Guadalupe-Nipomo Dunes Geophysical and Sediment Sampling Cruise July 2016
Offshore Seismic Research Projects
Surficial Seafloor Sediment Sampling

I. Objective

Acquire Multibeam data, collect high-resolution CHIRP seismic data, and collect surficial sediment.

II. Scope of Work

CHIRP (Compressed High Intensity Radar Pulse) seismic data was collected to image the architecture of the Holocene sand wedge, post-transgressive deposits, and deposits dating before the Last Glacial Maximum (LGM). These data will collectively be interpreted to understand the depositional history of the continental shelf and how it relates to changes in sea level and sediment supply. Of particular interest is the Holocene sand wedge because it supplies sediment to the Guadalupe-Nipomo Dunes. Variability in the thickness of this wedge will be quantified in order to understand more about the sediment budget in the Santa Barbara Littoral Cell.

Multibeam bathymetry data was collect in order to construct a high-resolution bathymetry map. In addition, this dataset also includes backscatterance and reflectivity data, which can be used in conjunction with surficial sediment grabs to understand surficial sediment. Surficial sediment grabs were collected in three transects, and grain size analysis of each sample will aid in understanding sediment transport processes and how sand is supplied to the dunes.

Scope of work will include the following activities:

- Acquire CHIRP seismic data and process. Thicknesses of deposits will be calculated and mapped. The architecture of the shelf and its relationship to sea level rise will be interpreted.
- Collect Multibeam bathymetry, process it, and produce a high-resolution map of the seafloor to 5 m depth
- Collect surficial sediment grabs which will be analyzed for grain size
- Grain size, backscatterance, and sediment thickness data will be used to understand sand mobility to the dunes

Acquisition and processing of CHIRP Seismic Data

All cruise activities were conducted on the R/V Point Loma, which is operated by the Scripps Institution of Oceanography. The R/V Point Loma is 32 feet long and was mobilized each morning from Port San Luis to the study area.

In July 2016, 19 lines totaling 79 km of CHIRP seismic data were acquired on the continental shelf offshore of the Oceano Dunes in Central California. The strike and dip lines constructed a grid that covered an area that was approximately 83 km^2. CHIRP Seismic data was collected by towing the Scripps Institution of Oceanography EdgeTech X-Star CHIRP subbottom reflection sonar a few meters below the surface. For this survey, the CHIRP unit utilized 30 ms 1-1.5 kHz swept frequency acoustic source, which allows it to acquire sub-meter vertical resolution and seafloor penetration up to 50 meters. Data were recorded in SEG-Y format with real-time GPS navigation recorded with each shot for location accuracy.

The data were processed and heave was removed using SIOSEIS (Henkart, 2003) and then imported into the Kingdom software package (Kingdom.IHS.com) for interpretation.

SIOSEIS processing yields plots of the seismic data that are shown in the following sections. Kingdom Suite was used to calculate the depth to and thickness of interpreted surfaces. Once the thickness is calculated, this data can be loaded into Generic Mapping Tools (GMT; gmt.soest.hawaii.edu), where a continuous surface algorithm is used to convert points to a gridded surface, producing an isopach map.

Figure 1: The R/V Point Loma is operated by the Scripps Institution of Oceanography and is 32 feet long. An electric winch off the starboard side allows for acquisition of CHIRP seismic data.

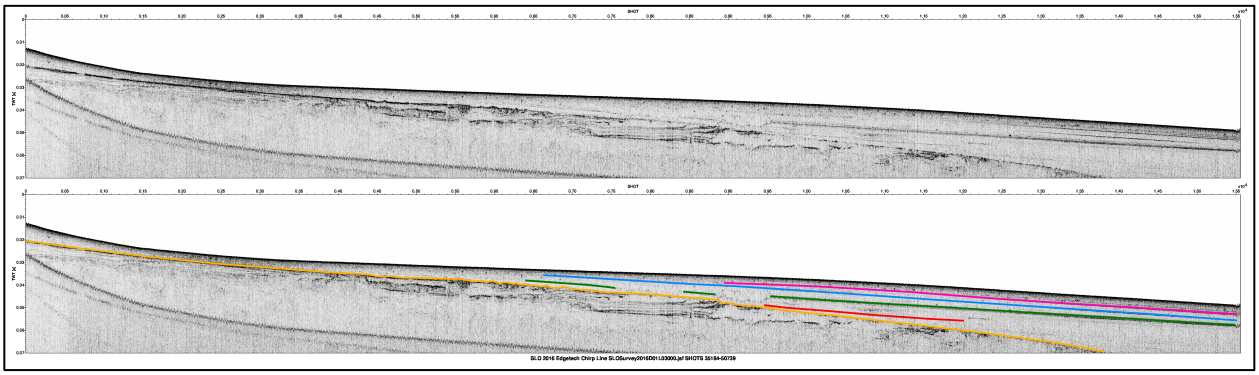


Figure 2: An uninterpreted CHIRP dip profile (above) and the same profile with interpreted sediment packages (below).

Multibeam bathymetry acquisition and processing

The bathymetry of the shelf was mapped from the 5-40 m depth contours using a RESON SeaBat 7125 multibeam system. This system utilizes a 200 kHz frequency to acquire high-density bathymetry that approaches ~2 cm vertical resolution. Before acquisition, a sound velocity profiler (SVP) is lowered to the seafloor. Since the sound velocity structure of the water column can affect how the Multibeam beams propagate through the water column, an SVP aids in steering the beams. At the time of acquisition, boat motion is recorded by the Inertial Motion Unit (IMU), which automatically applies corrections of motion to the real-time data. Accurate GPS recordings are taken by connecting to the California Virtual Reference Station (CalVRS)

network through a cellular phone as an internet connection to a webserver computer. The VRS system pings on several different base stations in a network and interpolates the correction values between stations and allows us to record location accuracy with fixed Real Time Kinematics.

Once the data are collected, it is loaded into the Caris 9.1 Hips and Sips software package and processed. Processing steps within Caris utilizes a CUBE (Combined Uncertainty and Bathymetric Estimator) algorithm (e.g. Calder, 2004). CUBE is an error-based model that estimates the confidence interval for each node point in order to estimate the probable depth of that point. A gridded surface is then fit through the probable depths and the erroneous data points are deleted.

Along with bathymetry, the RESON system also collects acoustic backscatter data. This data was loaded and processed with Caris to produce a map of seafloor reflectance.

Surficial sediment grabs

Three transects of surficial sediment grabs were conducted in the Southern, Central, and Northern areas of the survey. Each transect was taken along a seismic dip profile. Surficial grabs were acquired between the depths of 6-20 m at depth intervals of 2 m.

Grabs were acquired with a van Veen core sampler by lowering it to the seafloor. Before deployment, two levers are spread open and locked and the trigger mechanism is set. When the sampler hits the seafloor, the levers are unlocked. The trigger mechanism closes when the rope pulls the sampler upward. This closes the sampler and allows it to recover surficial sediment.

In the lab, surficial sand samples will be dried, weighed, and sieved to calculate the grain size.

III. Survey Information

Weather and Sea State During Operations

Weather and sea state varied during operations. Skies were overcast in the morning with some fog on some days. On days with fog, transits occurred at slow speeds, precaution was taken, and the fog horn and ship radar were used. In the early afternoon, winds picked up, causing white caps and swell ranging from 3-6 feet. At the first sightings of white caps, the survey was wrapped up, equipment was recovered and secured, and precaution was taken on the transit back to Port San Luis.

Dates and Times of data collection

Geophysical survey data were collected continuously over the following dates and times in 2016:

Multibeam Survey:
15 July: 10:02 – 16:06
16 July: 9:13 – 15:02
17 July: 9:23 – 14:58
18 July: 9:16 – 16:24
19 July: 9:45 – 12:35
20 July: 8:57 – 10:21
21 July: 8:49 – 8:53
25 July: 10:19 – 18:15

CHIRP Survey:
26 July: 8:43 – 14:09
27 July: 8:25 – 13:34

Accident, Injury, Damage, or Loss of Property

There were no accidents, injuries, damage to or loss of property during this survey effort.

Biological Information

Table 3 provides a list of marine mammals observed during transit and/or during survey operations. The two most common animals spotted were California sea lions (*Zalophus californianus*) and Southern sea otters (*Enhydra lutris nereis*). Common dolphins (*Delphinus sp.*) were seen in large numbers. On 17 July, a pod of Common dolphins approached the ship and logging was stopped and the geophysical source for the Multibeam was shut down (see Shut Down section). During other dolphin sightings, the pod of dolphins was located outside of the survey exclusion zone. Additionally, there were occasional sightings of Humpback whales that were located outside of the survey exclusion zone.

No sea turtles were observed either in transit or during survey operations.

Seabirds were observed frequently during transit and survey operations. Large flocks of Sooty shearwaters (*Puffinus griseus*) were observed, apparently feeding on schooling fish. No marine mammals were associated with the feeding aggregations.

Description of Shut Downs

17 July, 2016, 12:24 – A pod of 2 common dolphins approached the bow of the vessel. As they approached, the Multibeam was turned off. The speed of the vessel slowed down. The pod of dolphins passed us in the opposite direction. When they were located outside of the survey exclusion zone, the Multibeam was turned on and logging resumed.

Collision Events

There were no collision events during this survey effort.

Marine Wildlife Monitor Evaluation

The R/V Point Loma was an excellent platform for marine wildlife monitoring. The captain and survey crew were exceptionally responsive during the entire survey effort and specifically during shut-down events. The entire crew remained vigilant and supplemented the observation effort during transits and surveys.

Individual animals (with the exception of the two dolphins) passed through the periphery of the zone very quickly making a shut down of the survey impractical.

IV. Specific Deliverables with Status

- Bathymetric map
- Backscatterance map
- Thicknesses and volumes of recent sediment deposits
- Grain size composition % for surficial sediment grabs

References

Calder, B.R., 2004. CUBE and Navigation Surface: New Approaches for Hydrographic Data

Processing and Management.
Henkart, P., 2003. SIOSEIS software. Scripps Institution of Oceanography, La Jolla, California.

Table 1: CHIRP Survey Track line coordinates

Day	Line name	Start Longitude (°)	Start Latitude (°)	End Longitude (°)	End Latitude (°)	Length (km)
1	D01L01	-120.713257	35.114587	-120.63929	35.115527	6.993
	D01L02	-120.638615	35.115177	-120.638363	35.103068	1.519
	D01L03	-120.638786	35.101815	-120.71425	35.100533	7.136
	D01L04	-120.715226	35.099935	-120.71276	35.088399	1.374
	D01L05	-120.711825	35.087528	-120.635343	35.087032	7.104
	D01L06	-120.634855	35.086385	-120.636133	35.073018	1.591
	D01L07	-120.636532	35.07242	-120.712614	35.072046	7.104
	D01L08	-120.71425	35.070561	-120.713786	35.059965	1.253
	D01L09	-120.712842	35.05887	-120.636133	35.058187	7.146
	D01L10	-120.635677	35.057548	-120.63929	35.044104	1.675
	D01L11	-120.63999	35.043437	-120.642163	35.043473	2.049
2	D02L01	-120.661051	35.125045	-120.658797	35.030192	1.109
	D02L01A	-120.658797	35.030192	-120.658854	35.009111	2.450
	D02L02	-120.659375	35.010205	-120.639844	35.028011	2.801
	D02L03	-120.640666	35.028691	-120.713037	35.029675	6.801
	D02L04	-120.712826	35.033993	-120.71359	35.043294	1.142
	D02L05	-120.712931	35.043917	-120.638322	35.043058	6.952
	D02L06	-120.638997	35.043831	-120.640291	35.122734	9.662
	D02L07	-120.64091	35.123112	-120.643896	35.123185	2.855

Table 2: Location of van Veen core grabs

Sample Name	Latitude (°N)	Longitude (°E)	Depth (m)	Seismic Line	Sediment type	Notes
S08	35.0273	-120.6500	8	D02L03	Medium sand, sand dollars (SDs) at top	had to deploy twice, first recovered SDs
S10	35.0285	-120.6432	10	D02L03	Medium sand with SDs	-
S12	35.0285	-120.6439	12	D02L03	No sand, 3 SDs	-
S14	35.0290	-120.6483	14	D02L03	Medium grained with SDs	-
S16	35.0291	-120.6516	16.1	D02L03	sand with SDs	16a was first deployment with 2 SDs, 16b and c were successful deployments with sand
S18	35.0282	-120.6483	18.6	D02L03	sand, lots of iron-stained quartz, some shells	
S20	35.0285	-120.6545	20.3	D02L03	-	-
C06	35.0666	-120.6338	6.5	D01L07	sand and SDs	not much sand: really

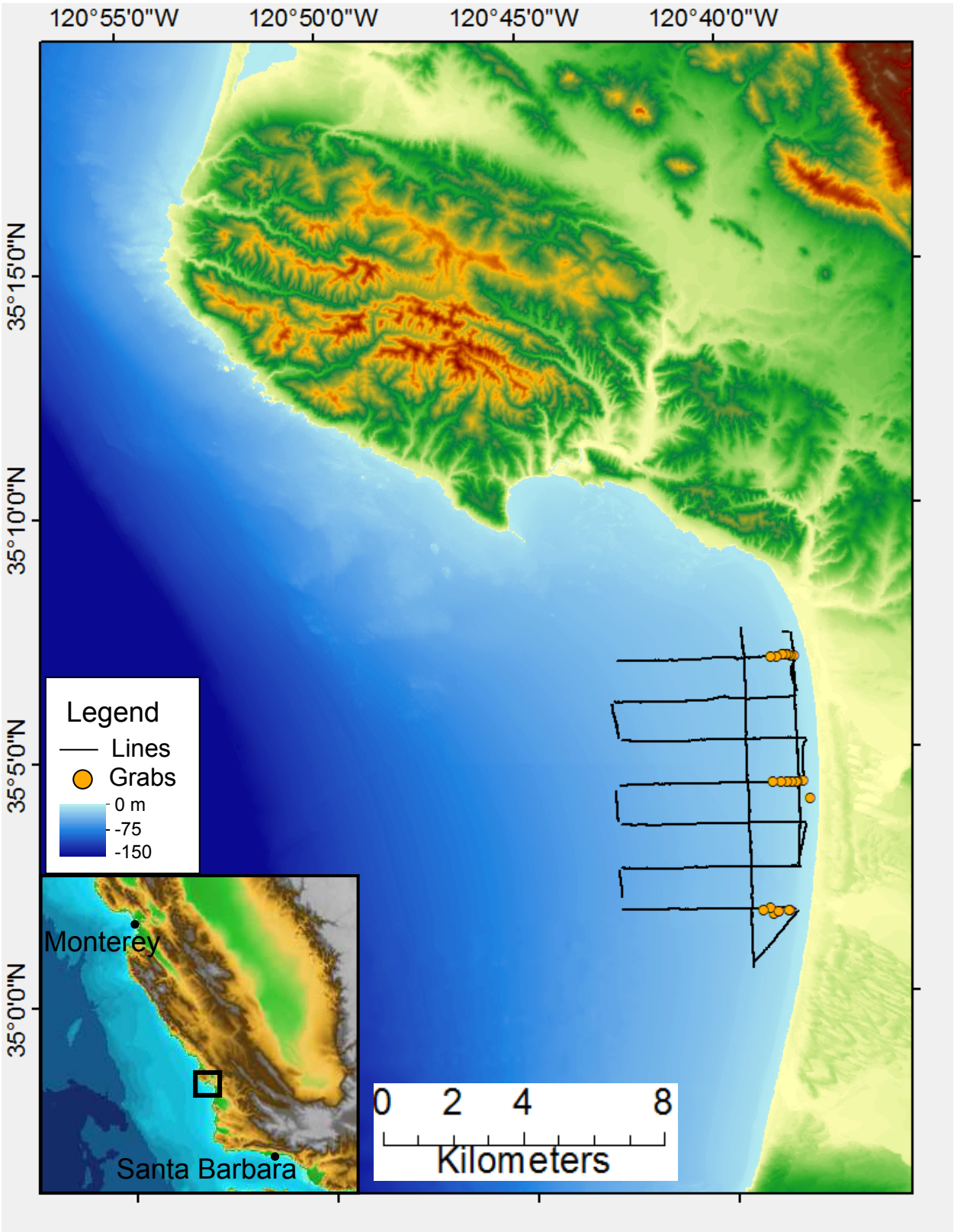
						watery and sand ran out bottom of van Veen
C08	35.0724	-120.6365	8.78	D01L07	sand dollars	C08a has only sand dollars. Nothing in C08b
C10	35.0722	-120.6391	10.3	D01L07	snails and crabs with sand	-
C12	35.0721	-120.6393	12.5	D01L07	only SDs, did not recover a sample	-
C14	35.0722	-120.6414	14.6	D01L07	SDs andwatery med-grained sand	-
C16	35.0722	-120.6436	16.4	D01L07	very little sand, mostly SDs	C16a was 1st deployment with only SDs, C16b was 2nd deployment, very little sand
C18	35.0722	-120.6456	18.1	D01L07	some but not much sand, lots of SDs	-
C20	35.0723	-120.6491	20	D01L07	-	-
N06	35.1153	-120.6394	6.4	D01L01	lots and lots of sand, no SDs	-
N08	35.1154	-120.6406	8.74	D01L01	sand	had to do 2 deployments
N10	35.1156	-120.6417	11.2	D01L01	good sand	-
N12	35.1156	-120.6428	12.8	D01L01	good sand, also recovered chlorite pebble	pebble in a separate bag
N14	35.1156	-120.6441	14	D01L01	really dark sand, organic matter	-
N16	35.1152	-120.6465	16.9	D01L01	Really dark, mostly organic matter	-
N180	35.1150	-120.6490	18.1	D01L01	dark colored sand	-

Table 3: Marine Mammal sightings

Date	Time	Latitude	Longitude	Animal	Notes
6-Jul-16	12:10	32.99816667	-117.3633333	porpoise	transit day
	14:49	33.42916667	-117.6974833	50 porpoises	SD--> Dana Pt
7-Jul-16	8:04	33.52995	-117.9505	~20 dolphins	transit day
	8:46	33.6279	-118.1709833	~15 dolphins	Dana Pt --> Ventura
	10:43	33.89318333	-118.7381667	~50 dolphins	
	11:34	33.94723333	-118.8907333	Humpback whale	
	12:18	33.94138889	-118.8848889	Dolphin pod, 25	
	13:21	34.08696667	-119.14555	Dolphin pod	
	14:59	34.20761667	-119.1042667	Dolphin pod	
12-Jul-16	8:46	34.3611	-119.6321	Sea lion	transit day
14-Jul-16	9:40	35.11095	-120.62795	Sea otter	Survey: Multibeam only, 200 kHz
	9:51	35.11095	-120.62795	Seal	
15-Jul-16	12:41	35.05527778	-120.6490278	Sea lion	Survey: Multibeam
	16:00	35.11305556	-120.6487417	2 Sea otters	
16-Jul-16	8:06	35.128084	-120.647058	18 Sea otters	Transit from SLO Bay --> Oceano beach
	8:15	35.122793	-120.647776	Sea otter	Survey: Multibeam
	8:21	35.112601	-120.648043	Sea otter	40 m away
	8:40	35.0815	-120.648	Sea otter	30 m away
	8:55	35.0547	-120.647	California sea lion	10 m away
	9:07	35.033429	-120.645772	Seal	50 m to port
	9:10	35.029137	-120.645671	Mola mola, 4 sea lions	
	9:27	35.047041	-120.645725	3 Sea lions	
	9:51	35.090985	-120.646919	2 Sea otters	
	9:54	35.095919	-120.646926	Sea lion	
	10:12	35.119447	-120.646842	Porpoise	
	10:49	35.113	-121.355	Sea lion	
	10:58	35.12055	-120.6454	2 Sea lions	
	11:02	35.12	-120.64415	2 Sea lions	
	11:16	35.09165	-120.6449833	Sea otter	
	11:23	35.08488333	-120.6457667	Sea otter	
	12:49	35.09786111	-120.6441861	1 Dolphin	
	12:52	35.10378061	-120.6436889	2 Sea lions	
	12:58	35.11476111	-120.6435111	1 Sea otter	
	13:18	35.096303	-120.643627	Sea lion	
	13:39	35.06006	-120.644206	Sea lion	
	14:55	35.112978	-120.642715	Porpoise	
17-Jul-16	7:59	35.127625	-120.656176	Sea otter	Survey: Multibeam

	8:45	35.091102	-120.642391	Sea otter	
	9:39	35.0328	-120.64226	Bull sea lion	
	12:24	36.11162	-120.64126	Pod of common dolphins	Stopped logging. Shut down Multibeam
	14:23	35.071153	-120.640243	Sea otter	
	14:40	35.101858	-120.639578	Sea otter	
	14:45	35.11206	-120.63982	Sea lion	
18-Jul-16	7:38	35.173821	-120.68665	Sea otter	Survey: Multibeam
	7:41	35.131814	-120.67564	5 Sea otters	
	8:29	35.09955	-120.639384	Sea lion	
	9:16	35.09996	-120.697315	Sea otter	
	9:48	35.057695	-120.647221	Seal	
	11:17	35.101887	-120.638947	2 Dolphins	
	11:38	35.110897	-120.6388	Sea otter	
	11:44	35.100828	-120.638555	Sea otter	
	13:14	35.054025	-120.639023	Sea otter	
	13:41	35.096	-120.678259	Sea lion	
	13:53	35.114048	-120.639044	2 Sea otters	
19-Jul-16	8:52	35.111956	-120.638146	Dolphin	Survey: Multibeam
	10:11	35.041894	-120.63852	Dolphin	
	10:23	35.064346	-120.637956	5 Dolphins	
	10:34	35.084707	-120.637096	Sea otter	
20-Jul-16	8:14	35.10121	-120.64679	Dolphin	Survey: Multibeam
25-Jul-16	7:55	35.10551	-120.64774	Humpback whale, Seal	Survey: Multibeam
	9:30	35.08394	-120.63618	Dolphin	
	9:55	35.07524	-120.63877	Seal	
	9:59	35.07046	-120.63628	Sea lion	
	10:19	35.03933	-120.63801	4 Dolphins	
	10:24	35.04286	-120.63735	2 Dolphins	
	11:23	35.06416	-120.64317	Sea otter	
	11:33	35.06333	-120.64065	Sea otter	
	13:24	35.02938	-120.63851	Sea lion	
	13:26	35.03354	-120.63807	Sea otter	
	13:40	35.05765	-120.63556	Seal	
	13:46	35.06767	-120.646567	Dolphin	
	14:04	35.09941	-120.63554	Seal	
	14:06	35.10282	-120.63581	Seal and Sea lion	
	16:31	35.08209	-120.635	2 Sea otters	
26-Jul-16	9:14	35.11453	-120.6816	Sea otter	Survey: Multibeam
	9:35	35.11488	-120.65392	2 Sea otters	
	9:40	35.11501	-120.64622	2 Sea otters and	

				a Seal	
	10:00	35.10096	-120.64698	Seal	
	13:56	35.05823833	-120.6371733	Sea lion	
27-Jul-16	8:25	35.12371	-120.66079	Sea otter	Survey: CHIRP Subbottom
	8:32	35.12112	-120.6605	Seal	100 m starboard
	8:33	35.11985	-120.66034	Sea otter	
	8:34	35.1129	-120.65971	Seal	
	8:36	35.10908	-120.65971	2 Sea otters	
	8:45	35.09621	-120.65965	Seal	Outside of exclusion zone
	9:13	35.0619	-120.65909	Sea lion	Outside of exclusion zone
	13:31	35.12262	-120.64022	Sea otter	
28-Jul-16	11:28	34.4042	-120.2052	Pod of dolphins	Survey: CHIRP, outside of exclusion zone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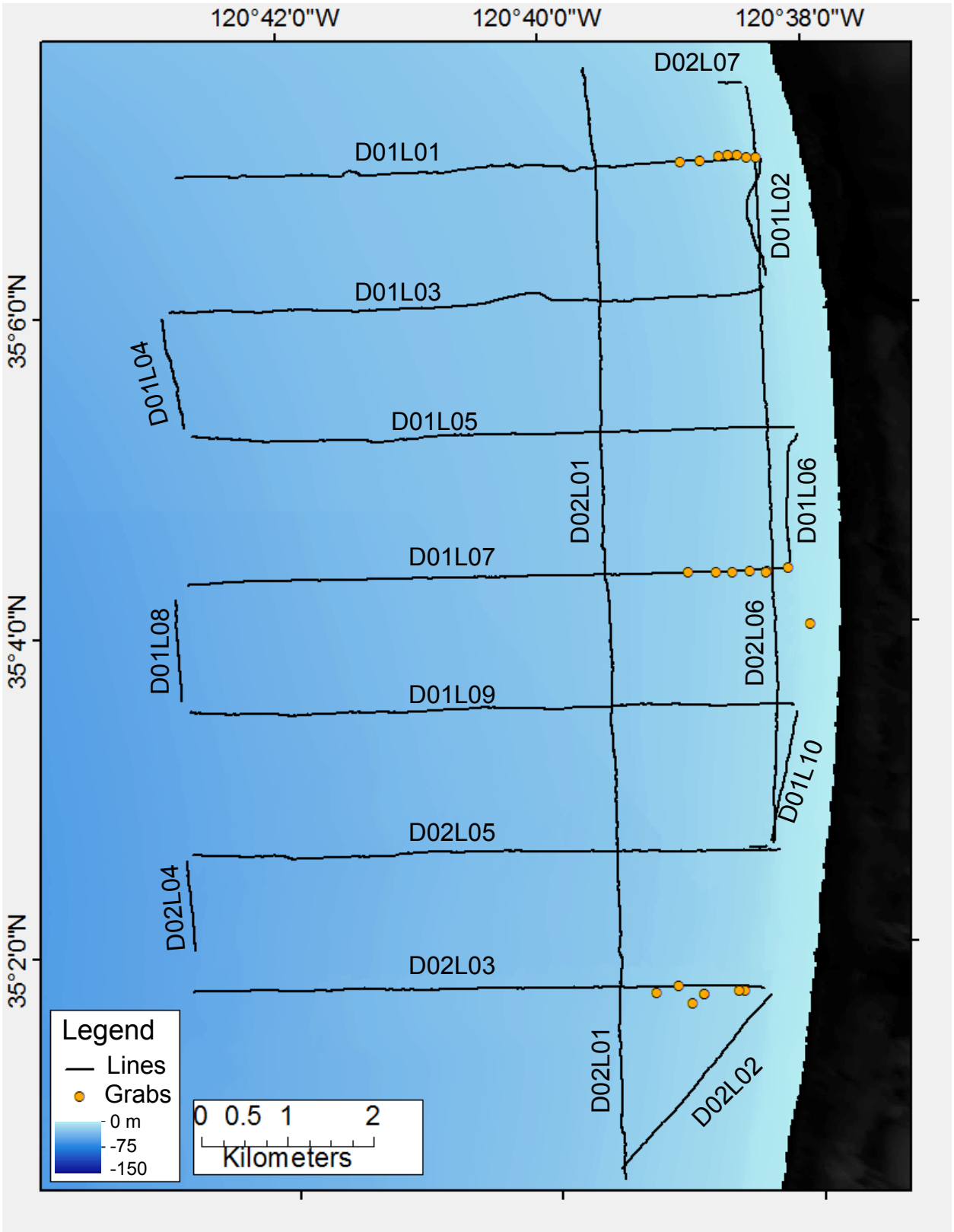
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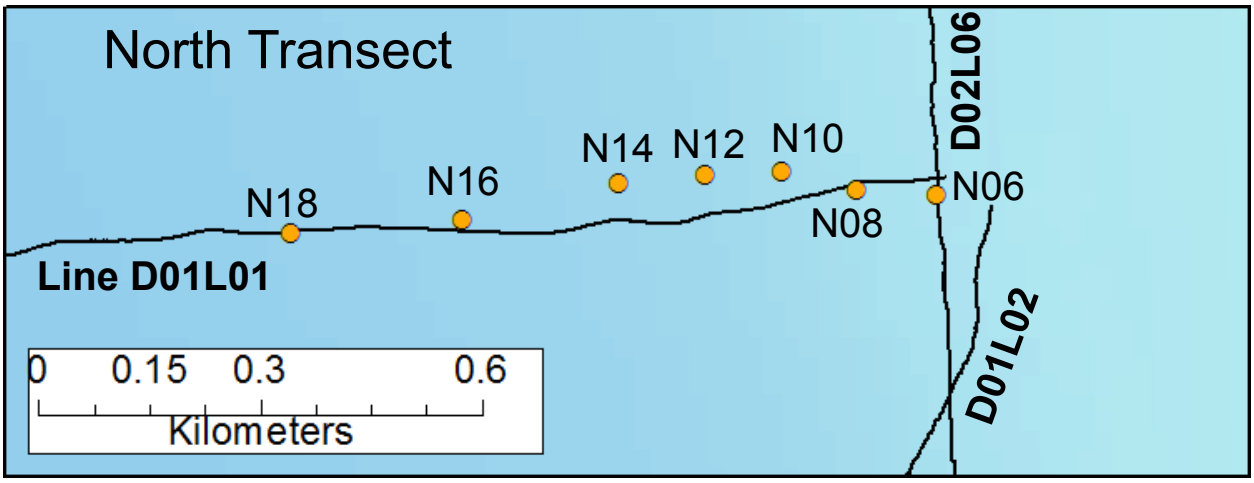
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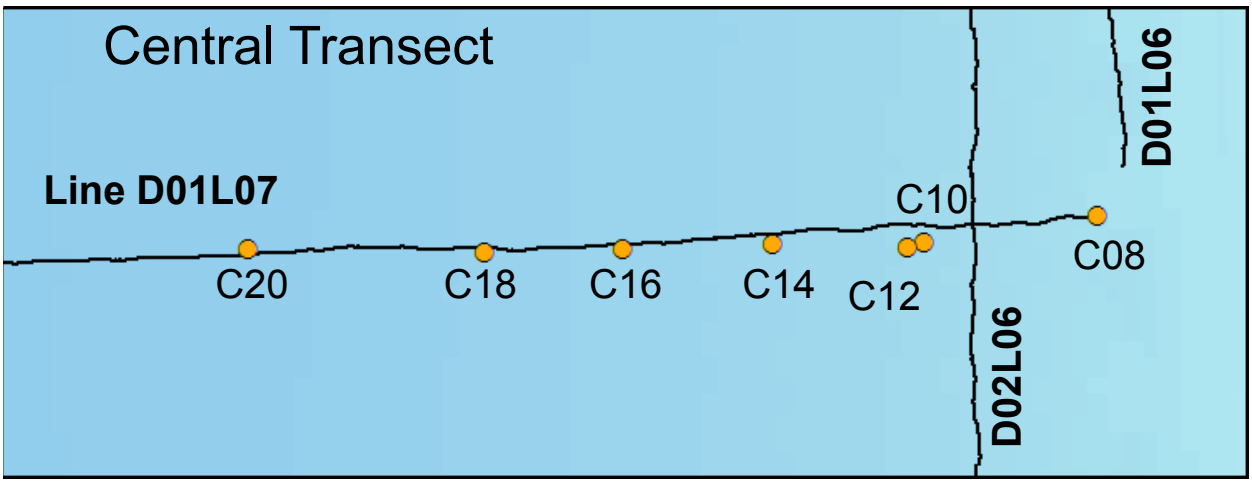
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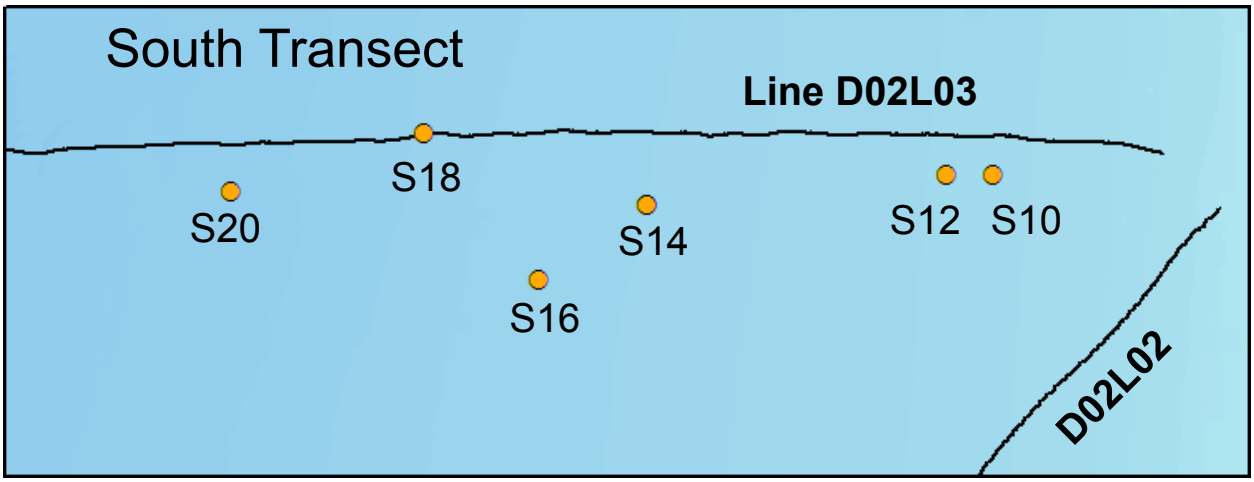
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